

TABLE 2.—Free-air resultant winds based on pilot balloon observations made near 5 p. m. (75th meridian time) during May 1942. Directions given in degrees from North (N=360°, E=90°, S=180°, W=270°)—Velocities in meters per second—Continued

Altitude (meters) m. s. l.	New York, N. Y. (15 m.)			Oakland, Calif. (8 m.)			Oklahoma City, Okla. (402 m.)			Omaha, Nebr. (306 m.)			Phoenix, Ariz. (338 m.)			Rapid City, S. Dak. (982 m.)			St. Louis, Mo. (181 m.)			San An- tonio, Tex. (180 m.)			San Diego, Calif. (15 m.)			Sault St. Marie, Mich. (230 m.)			Seattle, Wash. (12 m.)			Spokane, Wash. (603 m.)			Washing- ton, D. C. (24 m.)				
	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity	Observations	Direction	Velocity					
Surface.....	31	176	3.6	31	268	5.9	31	179	3.9	30	179	2.8	31	247	2.1	28	17	1.0	31	216	2.4	31	128	3.2	31	259	4.1	29	273	2.2	30	239	2.1	29	244	1.5	31	185	1.8		
500.....	31	206	5.0	31	282	4.8	31	182	4.4	30	176	2.9	31	256	2.9	31	16	0.8	31	214	2.3	31	125	4.2	31	275	3.5	29	244	1.3	30	229	2.3	31	208	2.4					
1,000.....	28	247	4.5	30	287	3.5	31	187	5.2	28	188	3.8	31	234	2.4	28	16	0.8	30	213	3.2	30	125	4.5	25	295	2.8	28	229	1.4	27	214	3.1	29	232	1.7	29	234	3.0		
1,500.....	27	259	5.8	28	280	2.4	31	200	6.0	26	207	4.7	31	214	3.1	28	334	1.3	25	226	5.4	25	154	3.9	24	290	2.4	24	203	1.7	21	211	3.0	28	232	1.6	29	251	4.1		
2,000.....	23	268	7.2	27	283	2.9	30	228	7.2	21	222	5.1	31	216	4.4	23	270	2.3	21	242	5.8	23	185	4.3	23	267	2.4	22	253	1.4	18	202	3.0	26	213	1.8	25	259	5.1		
2,500.....	20	268	7.7	27	280	3.7	25	241	8.0	17	230	7.1	31	225	6.3	20	274	4.4	18	244	6.3	19	207	3.8	23	273	4.5	18	290	1.6	16	201	4.3	23	237	2.8	20	259	6.4		
3,000.....	15	277	8.1	27	284	5.3	23	252	10.0	12	246	8.2	31	235	7.6	18	276	6.4	16	255	6.4	15	259	4.4	21	270	7.3	15	303	3.1	14	183	4.9	14	229	3.2	18	246	6.4		
4,000.....	---	---	---	25	290	7.1	21	260	12.3	---	---	---	31	250	10.2	16	290	9.8	10	283	7.6	14	287	6.5	19	276	10.8	13	303	5.3	13	205	4.7	---	---	---	14	266	8.1		
5,000.....	---	---	---	23	285	10.7	20	267	14.1	---	---	---	31	252	13.8	13	297	10.8	10	289	11.1	13	284	7.5	17	271	13.5	---	---	---	---	---	---	---	---	---	11	278	7.0		
6,000.....	---	---	---	21	286	13.5	19	272	14.7	---	---	---	30	258	15.0	11	293	10.9	---	---	---	12	286	9.2	15	269	13.8	---	---	---	---	---	---	---	---	---	---	11	282	6.8	
8,000.....	---	---	---	15	294	19.5	14	269	18.0	---	---	---	27	262	17.4	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
10,000.....	---	---	---	10	283	21.4	11	280	24.4	---	---	---	20	259	23.9	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
12,000.....	---	---	---	---	---	---	---	---	---	---	---	---	16	268	27.4	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
14,000.....	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

\*Moved to St. Paul elevation 225 (May 28 to 31 incl.).

TABLE 3.—Maximum free-air wind velocities, (m. p. s.), for different sections of the United States, based on pilot-balloon observations during May 1942

Section	Surface to 2,500 meters (m. s. l.)					Between 2,500 and 5,000 meters (m. s. l.)					Above 5,000 meters (m. s. l.)				
	Maximum velocity	Direction	Altitude (m) m. s. l.	Date	Station	Maximum velocity	Direction	Altitude (m) m. s. l.	Date	Station	Maximum velocity	Direction	Altitude (m) m. s. l.	Date	Station
Northeast <sup>1</sup>	42.4	W	1,860	3	Akron, Ohio	41.2	W	4,780	5	Boston, Mass.	61.6	SSW	10,020	25	Portland, Maine.
East-Central <sup>2</sup>	28.1	SSW	990	7	Hatteras, N. C.	32.2	W	4,350	7	Knoxville, Tenn.	54.0	SW	7,650	27	Hatteras, N. C.
Southeast <sup>3</sup>	27.6	SSW	2,500	3	Birmingham, Ala.	29.5	SSW	2,630	3	Birmingham, Ala.	40.0	WSW	11,600	22	Tampa, Fla.
North-Central <sup>4</sup>	39.5	SW	1,000	2	Detroit, Mich.	35.0	WNW	4,960	5	Alpena, Mich.	56.0	WSW	9,520	28	Bismarck, N. Dak.
Central <sup>5</sup>	43.0	SW	1,530	11	St. Louis, Mo.	42.0	SW	3,090	13	Des Moines, Iowa	40.0	W	8,910	4	St. Louis, Mo.
South-Central <sup>6</sup>	32.9	SW	2,090	16	Amarillo, Tex.	34.0	SW	3,980	13	Oklahoma City, Okla.	58.5	W	11,110	15	Oklahoma City, Okla.
Northwest <sup>7</sup>	27.5	ESE	1,380	10	Havre, Mont.	29.2	WSW	3,010	27	Great Falls, Mont.	53.0	WNW	11,000	6	Boise, Idaho.
West-Central <sup>8</sup>	44.9	NW	2,090	13	Cheyenne, Wyo.	49.6	W	4,650	27	Reno, Nev.	68.0	NW	10,070	1	Redding, Calif.
Southwest <sup>9</sup>	41.0	SSW	2,280	30	Roswell, N. Mex.	51.2	SSW	3,360	26	Las Vegas, Nev.	65.3	W	7,530	2	Albuquerque, N. Mex.

<sup>1</sup> Maine, Vermont, New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania and Northern Ohio.<sup>2</sup> Delaware, Maryland, Virginia, West Virginia, Southern Ohio, Kentucky, Eastern Tennessee and Northern Carolina.<sup>3</sup> South Carolina, Georgia, Florida and Alabama.<sup>4</sup> Michigan, Wisconsin, Minnesota, North Dakota and South Dakota.<sup>5</sup> Indiana, Illinois, Iowa, Nebraska, Kansas and Missouri.<sup>6</sup> Mississippi, Arkansas, Louisiana, Oklahoma, Texas (except El Paso), and Western Tennessee.<sup>7</sup> Montana, Idaho, Washington and Oregon.<sup>8</sup> Wyoming, Colorado, Utah, Northern Nevada and Northern California.<sup>9</sup> Southern California, Southern Nevada, Arizona, New Mexico, and extreme West Texas.

## RIVER STAGES AND FLOODS

By BENNETT SWENSON

Devastating floods occurred in several tributaries of the Delaware and Susquehanna Rivers on May 22-23. Among the streams most seriously affected were the Lackawaxen, Lackawanna, Lehigh, and Schuylkill Rivers. Thirty-three lives were lost in Pennsylvania, due directly or indirectly to the floods, and property damage caused by the floodwaters has been estimated at \$13,000,000.

At the same time, excessive flooding occurred in headwater areas along a narrow fringe extending from the Delaware River Basin southwestward to western North Carolina.

In addition to high water and flooding in the Missouri, Arkansas, Red, and Trinity Rivers, continuing from April, numerous local floods occurred in various areas, severe in some cases, in the upper Mississippi Basin, and in the Dakotas and Montana.

The flow in the upper Rio Grande continued high and storage in New Mexico was the highest of record.

**Atlantic Slope drainage.**—Floods occurred during the month in most streams from the Delaware River Basin, southward to South Carolina. Especially damaging were

the floods of May 22-23 in tributaries of the Delaware and Susquehanna Rivers in eastern Pennsylvania and adjacent portions of New York and New Jersey. The Lackawaxen, Lehigh, and Schuylkill Rivers of the Delaware Basin, and the Lackawanna River draining into the Susquehanna River were the streams most seriously affected.

In the Lackawaxen River at Hawley, Pa., the crest was the highest ever known; in the Lehigh River at Bethlehem, Pa., the second highest of some 150 years of record occurred; in the Schuylkill River at Reading, Pa., the third highest stage of record since 1757 was reached; and in the Lackawanna River a stage of 2.6 feet above the high stage of March 1936 occurred at Scranton, Pa.

The greatest devastation occurred in the Lackawaxen River Basin. Of the 33 deaths in Pennsylvania, attributed directly or indirectly to the floods, 24 persons are known to have drowned or are still missing in this basin. Of the estimated \$13,000,000 damage caused by the floodwaters, 45 percent has been fixed for the Lackawaxen Basin. Five deaths and 45 percent of the damage occurred in the Schuylkill and Lehigh River Basins.

The weather preceding the floods was characterized by frequent rains over most of this area, during the first 3

weeks of May, with a period of heavy rains on the 16th-17th. Beginning on the 19th, successive heavy showers continued until the early morning of the 23d, the greatest intensity occurring generally between afternoon and midnight of the 22d.

The following meteorological analysis of the heavy precipitation of May 19-23 was prepared by the Weather Bureau Office, Harrisburg, Pa.:

The weather over the Susquehanna and Delaware River Basins during May 1942 was characterized by numerous periods of copious rainfall. These heavy rains developed from recurring clashes between warm moist currents of air advancing from the West Gulf Region into the Upper Ohio Basin and deep colder air currents advancing southeastward from Montana and the Dakotas. The circulations of these two radically different currents created a tendency for a cold cyclonic circulation aloft over the Lower Lake Region and the Middle Atlantic States. This contrast was frequently intensified by the presence of a second current of warm moist air advancing up the Atlantic Coast to the vicinity of the Chesapeake Bay Region. Thus was created a sufficient supply of moisture over eastern Pennsylvania and adjacent areas from which nature could produce heavy precipitation. On one or two occasions, the circulation was so complete that the normally dry air coming into Pennsylvania from the north and northwest was practically saturated although, moderately cool.

The rainfall period of the 19th to the 23d with very heavy rain recorded over the watersheds began with a moderately strong high pressure system becoming stationary over the Atlantic adjacent to the New England and New Jersey coasts. This prevented a weak frontal system, moving slowly eastward north of the Lakes, from passing across Pennsylvania normally. Another high pressure system developed over the Mississippi Valley and Western Lakes Region. During this time the Atlantic High continued a slow steady circulation of moist air in from the southeast, while warm moist air from the Gulf moved northward through the quasi-stationary frontal zone. The Mississippi Valley high pressure circulation continued slowly and steadily to bring in much colder air from the northwest in the surface layers, while aloft over Central United States the presence of cold air resulted in the formation of a cold cyclonic circulation of dry air. The momentum of this cyclonic eddy as it moved eastward helped to deepen and accelerate the northward flow of warm moist air from the Atlantic. The area of maximum convergence in the moist current over the western portion of the Delaware drainage area was also the area in which the initial orographic lifting of the warm moist current began. While earlier periods of rain were coincident with surges along the nearly stationary frontal system that persisted over Pennsylvania for approximately 5 days, the very heavy rains of May 22-23 occurred as a wave on the quasi-stationary front deepened and moved rapidly northward beyond Lake Ontario.

The contrast between the inherent qualities of the air masses on either side of the quasi-stationary front appeared remarkably strong on the midnight map of May 21-22. The Washington radiosonde showed a moisture content of 13.6 g./kg. at the surface, 13 g./kg. at 915 mbs. (3,000 ft. m. s. l.), and 8 g./kg. at 700 mbs. (8,500 ft. m. s. l.), while just under the level of freezing temperature (32° F.) on the sounding (near 12,000 ft.) the relative humidity was still high—94 percent with moisture content of 6 g./kg. This moist air was being slowly compressed against the eastern slopes of the Appalachians and being forced to ascend over the colder air which, in the lower levels, had a maximum saturation of 6-7 g./kg. As the moist air was conditionally unstable slight orographic lifting was required to set off heavy rain showers in northeastern Pennsylvania, southern New York and northwestern New Jersey. Extreme southeastern Pennsylvania and southern New Jersey received extremely light amounts of rain, although the same moist air current first moved over this area. Disastrous flash-floods in Delaware and Sullivan Counties of New York State and in eastern Pennsylvania reached their peak on the 23d due to excessive rainfall on the night of the 22d-23d.

The damage caused by the floods of May 22-23 in the Delaware River Basin (exclusive of the Schuylkill) is evaluated at approximately \$11,500,000. This figure includes all tangible losses, such as destruction of property (both residential and industrial), agriculture, highway and railroad damage. Intangible losses, such as loss of wages of employees, are not included. About one-half of the damage is estimated to have occurred along the Lackawaxen River, over 40 percent along the Lehigh River, and the remainder elsewhere. In the Lackawaxen Basin

alone, 24 lives were lost, of which 12 deaths occurred at Honesdale, Pa., and 9 deaths at Hawley, Pa. One death was reported at Allentown, Pa., in the Lehigh River Basin as the result of the flood.

The following is quoted from a letter received at the Weather Bureau Office, Trenton, N. J., from Mrs. Della Pennell, river observer at Hawley, Pa., relative to the flood at that place (times given are Eastern War Time):

I, among others at Hawley, am suffering from nervous strain due to that disastrous flood, the worst in the history of our town, that came so suddenly in the night of May 22-23. The waters began to recede about the middle of forenoon on the 23d. The highest river stage reading I got was 5.89 feet at 8 a. m. on the 22d. I took second reading at 1:15 p. m. and found the river had fallen to 5.69 feet, and as rain was light the remainder of the day, a flood did not seem imminent. It began to rain harder by showers at 5:30 p. m. continuing heavier and heavier when at about 10 p. m., volumes of water came down, never heard anything like it. Thunder and lightning accompanied the showers which continued until 3 a. m. the following day, when to our consternation, we found that we, on the east side, were cut off from all communications with the west side, or main part of town, and all other places. The bridge at the eddy where the gage was, had been swept away about 4 a. m. on the 23d soon after the other bridge over the Lackawaxen farther up stream went down. Buildings were carried away. Nine of our citizens were drowned, who went to their doom in their homes. I am sorry that at that most critical time I was unable to submit any information to you, with gage gone, no telegraph or telephone and not even mail service until following Tuesday (26th). The heavy rain was considered due to a cloud burst that was quite widespread. Much of Hawley, especially on low lands represents a shambles; loss to town is estimated to be one-half million dollars. The greatest volume of water fell between the hours of 10 p. m. May 22 and 3 a. m. of the 23d. Living on high ground, I was in no danger from flood at any time.

Losses in the Schuylkill River Basin have been estimated at over a million dollars and four lives were lost. From the survey that was made to determine the losses, most of the damage occurred at Reading, Pa. At that place a crest stage of 22 feet was reached between 7:30 and 9:30 a. m., E. S. T., of the 23d. In August 1933, a stage of 22.7 feet occurred.

Rain that fell over the Schuylkill River watershed on May 16-17 had thoroughly soaked the soil and all streams were running at high stages on the morning of the 21st. Scattered showers and thunderstorms occurred over portions of the watershed during the 21st and the forenoon of the 22d. In the afternoon and evening of the 22d, unusually heavy thundershowers again occurred over the basin above Reading. The rain ceased generally by midnight of the 22d-23d.

Rainfall amounts measured during the periods May 16-17 and 21-23 are as follows (the figures represent the 7 a. m. to 7 a. m., E. S. T., accumulated 24-hour amount of May 16-17 and the 72-hour amount of May 20-23, respectively): Myerstown, Pa., 2.07 and 4.37 inches; Pottsville, Pa., 2.86 and 5.60 inches; Tamaqua, Pa., 3.20 and 6.97 inches; Reading, Pa., 2.04 and 5.81 inches; Port Clinton, Pa., 2.90 and 6.69 inches; and Sellersville, Pa., 1.50 and 0.58 inches.

Of considerable importance is the fact that while heavy rains occurred in the Schuylkill Basin above Reading, the rains were very light in Perkiomen Creek which drains into the Schuylkill below Reading. This is represented by the rainfall amounts for Sellersville, listed immediately above. Had heavy rains occurred there much higher stages would have been reached in Philadelphia, which, as it was, escaped serious damage.

In the main Delaware River, the flooding was relatively light, except at Easton, Pa., where the Lehigh River empties into the Delaware, and immediately below. At Easton a stage of 28 feet, 6 feet above flood stage, was reached on May 24. A crest of 11.24 feet occurred at

Trenton, N. J., during the evening of May 23; this was followed by another rise, reaching a crest of 13.35 feet the morning of May 24.

Most of the streams in the upper Susquehanna River Basin were in flood on May 22-23 but the damage was relatively light except in the Lackawanna River Basin where destructive flooding took place as indicated previously.

Showers of excessive intensity began over the Lackawanna River watershed in the afternoon of the 22d and ended generally by midnight. The heaviest amount reported, 7 inches between 2 and 11 p. m., E. S. T., was measured at a station one mile east of Carbondale, Pa. Scranton, Pa., received only 2.65 inches in approximately the same period.

The Lackawanna River began rising rapidly shortly after the heavy rains began. In the evening the river stage at Scranton was 5.7 feet, flood stage 7 feet, and at 3 a. m. the next day (May 23) a crest stage of 11.6 feet was reached.

Considerable damage occurred at Scranton and in the valley between there and Carbondale. Damage estimates approximate \$800,000, with some 5,000 buildings inundated and 7 bridges destroyed. Only one death resulted (indirectly) from the flood.

Mr. West, Weather Bureau office, Scranton, Pa., comments as follows relative to weather phenomena observed during the afternoon of May 22:

As is often the case in the warmer months of the year, a thunderstorm developed over the West Mountain Ridge to the west of this city (Scranton) between 2 and 3 p. m. It seemed to move northeastward, paralleling the range and then was followed by further development to the southwest along the mountains and over the Lackawanna Valley. By a little after 4 p. m. the rain was falling in torrents, and continued until after 6 p. m. when there was a short lull followed by another spell of less intense rain between 7 and 8 p. m. A total of 2.65 inches of rain was recorded between 4 p. m. of the 22d to 1 a. m. of the 23d. We have had storms of much greater intensity of rainfall but none with such heavy rain over such a wide area.<sup>1</sup> As stated earlier, the storm activity seemed to grow along the West Mountain Range and to spread eastward from it.

The following tabulation gives the flood crest heights of the floods of May 1942, and the crests of previous maxima at several points in the tributaries of the Delaware and Susquehanna Rivers:

River and station	Period of record	Previous maximum		May 1942 gage height
		Date	Gage height	
Delaware River Basin:				
Lackawanna River:				
Hawley, Pa. <sup>1</sup> .....	1908	1936	Feet 13.9	Feet 20.13
Lehigh River:				
Lehigh, Pa. ....	1934	1936	13.1	15.6
Schuylkill River:				
Reading, Pa. ....	1757	1850	23.2	22.0
Pottstown, Pa. <sup>1</sup> .....	1902	1902	21.0	20.15
Susquehanna River Basin:				
Lackawanna River:				
Scranton, Pa. ....	1936	1936	9.0	11.6

<sup>1</sup> Record from U. S. Geological Survey.

Two rises occurred in the Potomac and James River Basins during the month. The first rise followed heavy rains on May 15-16 centered over the upper James River and the upper tributaries in the Potomac Basin. The rainfall amounts averaged 4 inches in the James Basin above Lynchburg, Va., about 2 inches in the North Branch of the Potomac above Cumberland, Md., and about 2.25 inches in the South Branch above Springfield,

W. Va., and in the Shenandoah River above Riverton, Va. Maximum amounts reported were over 6 inches at Montebello and Balcony Falls, Va., in the James Basin and 4.5 inches at Monterey, Va., in the Potomac Basin.

Showers occurred again on the 20th followed by heavy rains late on that day and continuing until the morning of the 22d, most of the rain occurring during the last 24 hours. The distribution of the rains on May 21-22 duplicated that of the storm of May 15-16 to a great extent. Generally in the second storm the amounts were somewhat less over the James Basin than in the first storm while in the Potomac Basin, the reverse was true except in the North Branch of the Potomac where the rainfall of May 21-22 was relatively light.

While no appreciable flooding resulted in the Potomac Basin from the first storm, the second storm produced the highest general rise in that basin since 1937. Losses were confined generally to the headwater areas and consisted principally of damage to prospective crops, land, fences, roads and bridges, with an estimated total loss of more than \$145,000 from incomplete reports. The crest reached Washington, D. C., on the afternoon of May 24 with a stage of 13.2 feet (flood stage 10 feet) at the Leiter gage above the city and 6.0 feet on the gage at the foot of Wisconsin Avenue (flood stage 7 feet).

In the James River Basin, general flooding occurred from both storms, the former rise being greater in the upper reaches while the latter rise attained greater heights in the lower reaches. The river crested at Richmond, Va., at 9.8 feet on May 18-19 and at 12.4 on May 24-25 (flood stage 8 feet). The losses in the James River floods totaled over \$16,000, about equally divided between the two floods and in both cases generally confined to the upper reaches.

Light to moderate overflows occurred in the Roanoke, Neuse, Pee Dee, and Santee River Basins from moderate to heavy rains on May 20-22. No damage of consequence was reported except in the Roanoke River, where a loss of \$13,500, mostly to prospective crops, occurred.

*East Gulf of Mexico drainage.*—The only flooding in the drainage took place in the Pearl River. The flooding, which was light, resulted from showers from the 12th to the 15th. The rainfall amounts varied from 2 to more than 8 inches during the storm period. Flood stage was exceeded at Monticello, Miss., by 0.4 foot and at Pearl River, La., by 1.8 foot.

*Upper Mississippi Basin.*—Thundershowers with excessive rainfall were quite general in the extreme upper Mississippi Valley and tributary streams from May 25 and extending to June 1. The area of heaviest precipitation was in the Chippewa and upper Wisconsin River Basins and in the section of the main Mississippi channel from St. Paul-Minneapolis to Lake Pepin. Light to moderate flooding occurred in the Chippewa, Wisconsin, Zumbro and Whitewater Rivers. The flooding continued into June and a detailed account of the flooding can not be given at this time.

Slight overflows occurred in the Des Moines River from the vicinity of Tracy, to Eddyville, Iowa, on May 13-14 and in the Meramec River Basin in Missouri, but there was no damage of consequence.

*Missouri River Basin.*—Scattered local floods occurred in small streams in Montana and the Dakotas. On May 13, severe flooding in the South Fork of McDonald Creek caused damage estimated at \$12,000. The flood resulted from heavy rain on the snow-laden eastern slope of the Big Snowy Mountains. On May 24, overflows of small creeks near Rothiemay, Mont., caused by a heavy thundershower, resulted in damage amounting to \$4,000.

<sup>1</sup> Reports received later showed that 7 inches of rain fell between 2 and 11 p. m., May 22, near Carbondale in the valley above Scranton.

During the latter part of the month some flooding occurred in the Sun and Missouri River Valleys near Great Falls, Mont. In South Dakota, a flash flood in Horsehead Creek near Oelrichs, killed five people and damaged railroad tracks.

Heavy rains in southeastern South Dakota from May 12-14, produced exceptionally high stages in the James and Big Sioux Rivers. In some cases the highest stages of record were reached or exceeded. The stages remained above flood stage for several days.

Floods occurred in the upper Solomon River at Beloit, Kans., and in the upper reaches of the Big Blue and Little Blue Rivers. The overflow in the Solomon River was slight and of short duration; the crest at Beloit was 3 feet above bankful on the 4th. In the Little Blue River the flooding was also light and confined to Nebraska areas. The crest of Beatrice, Nebr., on the Big Blue River was 1.6 feet above bankful on the 11th; at Barnston, Nebr., 6.2 feet above bankful on the 12th; and at Blue Rapids, Kans., 5.5 feet above bankful at midnight of the 12th-13th. Below the confluence of the Big and Little Blue Rivers the overflow was slight.

Damage from the flooding in the Blue River Basin in Kansas and Nebraska was estimated at \$43,000, most of which occurred in Gage County, Nebr., and in Marshall County, Kans., along the Big Blue River. Lower sections of Marysville, Kans., and Beatrice, Nebr., were flooded, the latter largely by creeks in flash floods, with considerable damage to city property, which is included in the above estimate.

The Grand River in Missouri was in light flood on two occasions during the month, on the 6th to the 8th and again from the 11th to the 29th.

On May 5, a flash flood induced by excessive precipitation in extreme northwestern Missouri caused slight property loss and moderate crop damage along the Tarkio River.

The Nemaha River in Richardson County, Nebr., was out of its banks on May 11-15. Severe damage was inflicted on highways, bridges and buildings with moderate crop damage.

Excessive rain which fell over the upper Salt Creek Basin in southern Lancaster County during the night of May 10-11, caused flood conditions in small streams and considerable damage between DeWitt and Lincoln, Nebr., and in parts of the City of Lincoln where one man was drowned and property damage was severe. Light damage was reported at a few places along Salt Creek between Lincoln and Ashland, Nebr.

The Missouri River at Nebraska City, Nebr., left its banks on May 6 and remained above flood stage until May 26. The flood, which was augmented by excessive precipitation in eastern Nebraska on May 11-12, crested at 18.43 feet on May 21, the highest stage of record at that point. Extensive flooding, especially in Fremont and Mills County, Iowa, occurred with severe loss to prospective crops.

In the extreme lower Missouri River, light to moderate flooding prevailed in the entire reach from Lexington, Mo., to its mouth.

*Ohio River Basin.*—Heavy rains occurred in the upper basin of the French Broad River on the morning of May 20 and continuing as light to moderate to light rain on May 21, caused the river to overflow until May 23. Al-

though the average rainfall over the entire basin was not excessive, over 8 inches of rain occurred in the watersheds of the upper basin. The crest stage exceeded flood stage by almost 4 feet in the central portion of the basin and slightly less in the lower portion.

The greatest damage was inflicted in Henderson County, in the upper basin, where the heavy rain together with the overflow caused losses to crops, roads, bridges, cattle, and soil. Very little damage was reported in the middle basin, and none at all in the lower portion.

*White-Arkansas-Red Basins.*—Widespread floods in these basins during April, referred to in the April issue of the REVIEW, continued into May. As full information has not yet been assembled, the report on these floods will be made in the next issue of the REVIEW.

*West Gulf of Mexico drainage.*—The unusually high flood in the Trinity River during April continued into May. Further rains in May produced additional crests in the upper reaches but they were not as high as those in April. In the lower reaches the main crest was reached during May. A full report of these floods will be given in the next issue of the Review.

Precipitation over the watershed of the Rio Grande in New Mexico was the greatest of record for April, and a heavy flow into Elephant Butte Lake took place. Although high stages continued during both April and May, no serious peaks occurred. One rise occurred in the river above Elephant Butte Lake on April 23, and there were several minor levee breaks, but no appreciable damage occurred. There were two more peaks in May but as in April they passed without any serious damage. At the beginning of June, there was more stored water in New Mexico than ever before.

On April 13, water was allowed to pass through the spillway gates of Elephant Butte Dam. The amount released was increased irregularly until May 16. The river channel downstream was able to accommodate the heavy flow until the water reached the Candelaria-Presidio irrigation district, a narrow stretch extending along the river for about 40 miles. The highest stage in this reach occurred about May 27 and the flood continued after the end of May. About 3,500 acres of farm land were flooded on the American side of the river.

In the lower Rio Grande, flood stage was exceeded by .7 foot at Mercedes, Tex., on May 22-23.

*Gulf of California drainage.*—Run-off from melting snow produced high stages in the Gunnison and upper Colorado River during April and May. Two crests in April and two in May, at or above flood stage, were reached in the Gunnison River at Delta, Colo. The highest crest, 11.4 feet, occurred on May 27. The Colorado River, at Grand Junction, reached flood stage (11 feet) on May 27-28. Damage from the high water was slight.

*Pacific Slope drainage.*—Kings River was above flood stage at Piedra, Calif., on May 22-26 as a result of the first warm spell. No damage occurred as a maximum amount of water was used for irrigation purposes with the excess amounts going into Tulare Lake Basin.

The Columbia River reached a stage of 16.4 feet (flood stage 15 feet) at Vancouver, Wash., on May 30. No damage occurred.

NOTE.—A tabulation of flood losses and savings for May will be given in the next issue of the REVIEW, as estimates are to a great extent incomplete at this writing.